

INSTRUCTION MANUAL  
for  
MODEL FL-3D FLUTTER AND WOW METER

D & R, LTD.  
402 East Gutierrez Street  
Santa Barbara, California

1 March 1958

D & R, Ltd.

Instruction Manual

for

Model FL-3D Flutter and Wow Meter

GENERAL DESCRIPTION

The Model FL-3D Flutter and Wow Meter is a direct reading instrument designed to measure the flutter and wow frequencies found in tape recorders, turntables, disc recorders, and film recorders. The direct readings may be used for general maintenance or production testing. For research and development work, two output terminals are provided for analyzing the characteristic of the flutter. The output terminals on the front panel are provided for oscilloscopic display while a test point mounted on the rear chassis apron provides D.C. response so that drift as well as wow and flutter may be recorded on a direct recorder with suitable amplifiers.

The instrument has been designed to meet the requirements of the I.R.E. Standards-Methods of Determining Flutter Content, 53 I.R.E. 19.S2.

CIRCUIT OPERATION

The circuit utilizes the basic principles involved in the detection of F.M. Signals. This includes the use of a limiter amplifier to prevent the amplitude modulation components from producing an indication in the output circuits. Such A.M., for example, may be introduced by drop-outs in the magnetic coating of recording tape, clicks and pops in records, and light fluctuations in photo recording. A frequency discriminator demodulates

the flutter signals and presents them to an averaging-type meter circuit calibrated to read the RMS value of sine-wave modulation. Suitable filters are provided to examine the wow and flutter spectrums separately. A regulated power supply and internal 3000-cps carrier oscillator complete the circuit sections. Figure 1 illustrates the functioning of the FL-3D in block diagram form.

A two-section high-pass RC filter connects the INPUT terminals with the SET LEVEL control. The function of the filter is to remove low frequency components from the incoming flutter modulated 3 KC tone. The network attenuates frequencies below 1000-cps. The signal is next amplified in a Class A amplifier stage and feeds a symmetrical double-diode limiter. This circuitry has been designed for symmetrical clipping of the signal to avoid introducing phase modulation components on the main signal due to changes in the zero-axis crossings associated with nonsymmetrical limiting.

The limited signal is amplified and fed into the pentode section of the 6U8 which acts as the amplifier of the Foster-Seeley Discriminator. The detected flutter signal is taken from the 6AL5 detector and passed through appropriate filters to remove the carrier signal. A front panel control, DISCRIMINATOR CENTERING, is provided to allow the discriminator secondary tuning to be adjusted to the frequency of the incoming signal. Under most conditions, this control will be adjusted for 3000-cps operation which is the frequency of the factory-calibrated internal-carrier oscillator. The control may require adjustment when using a pre-recorded signal that is being played back at a slightly different speed, resulting in off-frequency operation. The bandwidth of the discriminator is such that a flutter

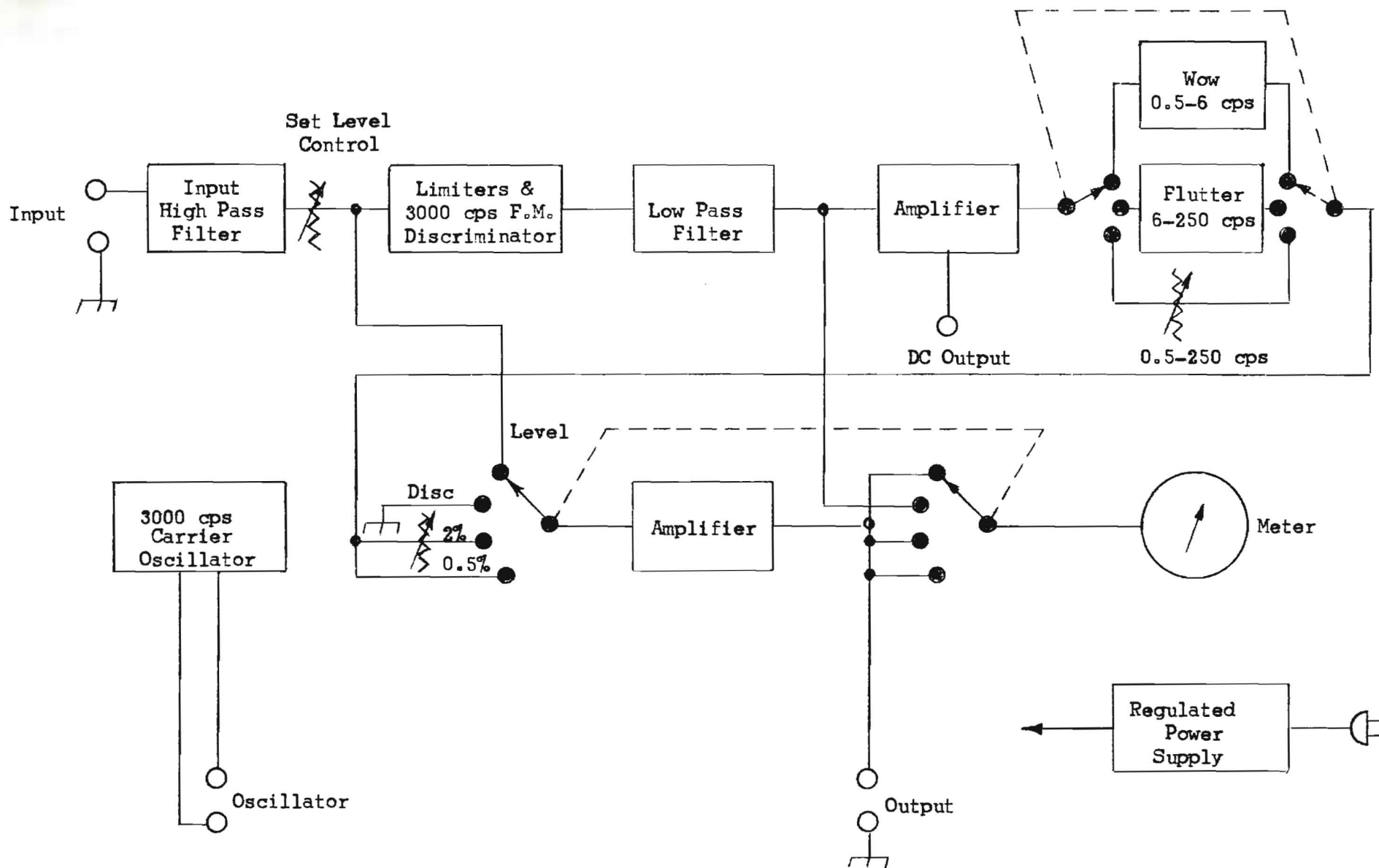


Figure 1

Block Diagram....Model FL-3D Flutter Meter

modulation signal of 250-cps is attenuated no more than 3 db from a reference frequency of 75-cps. Sufficient response is available to identify frequencies to 350-cps with an oscilloscope.

The demodulated flutter signal is amplified and fed to a selector switch which permits the wow, flutter, or over-all wow plus flutter components to be measured. The cathode of this amplifier tube is also connected through an isolating resistor to the test point on the rear apron for recording purposes. While a small positive quiescent potential is on this point, it can be bucked off by the appropriate centering controls on the direct recorder amplifier or by use of a small series battery. This D.C. response is valuable for drift measurements.

The filters to separate the wow and flutter components consist of three-section RC filters designed to give the sharpest knee characteristics. The cross-over frequency is 6-cps, which is in accordance with the I.R.E. standards.

After the signal has passed through the filters, it is again amplified and fed to a diode averaging circuit. Full scale meter sensitivities of 2.0% and 0.5% are provided on the FL-3D.

The selector switch for the flutter range also provides a position for monitoring the input signal for proper level setting and for connecting the meter across the discriminator to indicate proper center frequency adjustment.

The 3000-cps carrier oscillator is a standard Hartley circuit. Through the use of toroids and stabilized techniques, the stability of this oscillator is remarkable good. The output of the oscillator is



available on the front panel for recording purposes. Approximately 2.0 VAC is generated across a load impedance of 200 ohms. The frequency of the oscillator has been factory adjusted to 3000-cps. It may, however, be changed by the screwdriver control shaft on the rear of the unit. This control is normally locked in place with cement prior to shipment.

Regulated high voltage is provided by a voltage regulated glow discharge tube and will provide stable operation of the FL-3D over line voltage fluctuations of plus or minus 15% from 117 VAC. The power transformer will operate on a 50 to 400-cps input power frequency.

#### OPERATION

The D & R Model FL-3D Flutter Meter operates by virtue of measuring the degree of frequency modulation which is present on the 3000-cycle signal fed to the INPUT terminals. Hence, it is necessary first, in order to utilize the instrument, that a 3000-cycle signal be obtained which has been passed through the recording and reproducing media to be tested.

In the case of a tape system the 3000-cycle signal can be obtained in a relatively simple manner. With the usual tape recorder, the output from the OSCILLATOR terminals on the front panel is fed to the input of the tape recorder and the 3 KC signal is recorded on the tape in the normal manner. The tape is then rewound and the output signal from playing the recorded tape is fed to the INPUT terminals of the FL-3D. In this way the inherent flutter both of the tape recording process and the tape playback process of the particular tape machine under test will be measured.

If the tape machine has a monitor head, the measurement of flutter is made even simpler. The procedure is as follows: The output from the

OSCILLATOR terminals is fed to the input jack of the tape recorder, and is recorded on the tape at normal amplitude. Then the output from the monitor provision of the tape recorder is fed to the INPUT terminals of the FL-3D. In this way the flutter of the tape system may be measured at the same time that the signal is being recorded.

To make a flutter measurement on a disc or film system it is normal that the 3000-cycle signal be recorded on a machine separate from the playback instrument. Thus, two problems are interposed: (1) the difficulty of obtaining a disc or film record that is actually on 3000-cycles, and (2) isolating the flutter of the recording media from the flutter of the playback media. This is to say that it is extremely difficult to make a record in which the flutter recorded into the record is less than 0.1%. Also, it is less difficult a problem to make a disc playback turntable with flutter less than 0.1% than it is to make a recording system with an equivalent flutter level; this is true simply because the variable force components of a disc recording system are much greater than in the equivalent disc playback system.

#### MAKING A MEASUREMENT

First turn on the instrument and allow it to warm up for at least three minutes. The following steps are necessary to make a flutter measurement:

1. Connect the INPUT terminals of the FL-3D to the flutter modulated 3000-cps output signal of the unit to be checked. With the function control on LEVEL, adjust the SET LEVEL control until the meter reads Mid-scale. The input voltage required for this is approximately 0 dbm,

and will provide plus and minus 20 db of limiting. If the input signal is below this level, satisfactory operation may be obtained with a signal indicating 0.1% on the 0.5% scale with a corresponding reduction in the ability of the limiter to remove downward amplitude modulation. However, most records and tapes are such that this procedure will not introduce erroneous errors.

2. Rotate the function switch to the DISC position to check for center frequency tuning of the discriminator. A zero deflection of the meter indicates the discriminator is tuned to the same frequency of the incoming signal. A positive indication means the input signal is above the center frequency of the discriminator, and a below zero reading shows a lower incoming frequency. Adjust the DISCRIMINATOR CENTERING control for zero reading.

3. The function switch may be set to the 2.0% or 0.5% position to measure the wow, flutter, or over-all wow and flutter frequencies with the desired setting of the bandwidth switch. The indicated flutter is measured in terms of the RMS frequency deviation of the flutter or wow, expressed as a percentage of the average signal.

#### GENERAL INFORMATION

It should be pointed out that the instrument will give a meter indication when the INPUT terminals are open and the SET LEVEL control turned up. This is caused by the fact that extraneous signals picked up by the INPUT terminals are amplified and those components lying within the bandwidth of the FL-3D are detected. It is characterized by a rather steady reading of the meter and when observing the OUTPUT terminals with an oscilloscope,



a random, evenly distributed noise spectrum is seen. The same effect sometimes occurs as a result of thermal voltages present in the output amplifiers feeding the FL-3D without the presence of the 3000-cps signal. Upon applying the signal, however, the signal plus noise to noise ratio is such that only the flutter is indicated. This phenomenon can easily be verified by observing the flutter signal with an oscilloscope and then removing the 3000-cps input signal, but still leaving the amplifiers connected to the INPUT terminals.

In those cases where the incoming signal is higher in frequency than the 3000-cps internal oscillator, it is possible to obtain an estimate of the input frequency by first connecting the OSCILLATOR output to the INPUT terminals and adjusting the DISCRIMINATOR CENTERING control to a zero meter reading with the function switch in the DISC position. Next substitute the frequency to be measured for the carrier signal. An indication of 0.1% on the 0.5% scale indicates that the signal is approximately 2 1/2% higher than the 3000-cps reference.

Because of the relatively broad band response of the FL-3D discriminator coils and the tuning range of the DISCRIMINATOR CENTERING control, it is possible to accept input signals varying as much as plus or minus 5% away from the nominal, or 3000-cps input frequency without affecting the readings by more than 5%.

#### CALIBRATION

Each instrument is carefully calibrated at the factory before shipment. Since accurate calibration of a flutter measuring device requires specialized signal generating equipment and reference standards, it is not practicable

to calibrate the FL-3D in the field from a primary reference. However, calibration of the FL-3D from a standard tape or disc is rather easily accomplished. Hence, D & R can provide a standard calibration tape or disc with an accurately determined 1.5% peak flutter signal recorded on a 3000-cycles carrier. It should be pointed out that the Model FL-3D will measure the RMS value of this signal, or approximately 1.1%. If the calibration tape or disc is played on a machine having reasonably low flutter and wow content, the errors in this method of calibration are quite small, as the total reading will be the RMS value of the calibration signal and the inherent flutter of the playback machine. Under these circumstances, the error introduced in the calibration signal will be less than 2%. Both the standard flutter tape and the standard flutter disc contain also a 3000-cycle signal with no intentional modulation. This unmodulated 3000-cycle signal is held to as low inherent flutter as practicable; every effort is made in these recordings to keep the inherent flutter and wow below 0.1% peak.

## SPECIFICATIONS

Operating Frequency	3000-cps established factory calibration
Discriminator Bandwidth	The bandwidth of the discriminator is sufficient to allow sidebands up to 250-cps to be demodulated with no more than 3 db of attenuation with reference to 75-cps.
Input Signal Required	0 dbm signal provides <u>+</u> 20 db limiting. Full limiting can be obtained with as little as 0.1 V RMS signal input.
Input Impedance	100,000 ohms.
Scale Ranges	2% and 0.5% full scale. RMS calibration on sine-wave modulation.
Accuracy	10% within bandwidth restrictions.
Bandwidth Selection	0.5 to 6-cps, 6-cps to 250-cps, and 0.5 to 250-cps.
Outputs	a) Provision for D.C. to 250-cps output on rear apron for direct writing recorder and amplifier. b) Front panel terminals for observing flutter and wow components on oscilloscope.
Tube Complement	One 6U8, two 12AT7, two 6AL5, one 6X4, one OA2.
Line Power	117 volts, 50-400 cps, 30 watts.
Dimensions	7" x 12" x 6" steel case.
Weight	10 1/2 pounds.
Shipping Weight	14 pounds.

## ACCESSORIES

- Flutter Tape - Part No. 62-1002A - 600 ft. on 7" plastic reel, full width, 7.5-ips, first half 3 KC unmodulated, balance 1.5% peak flutter at 75-cps modulation frequency.
- Flutter Record - Part No. 37-1002 - 12" 33 1/3 vinyl pressing with three cuts: 1) 3000-cps unmodulated for flutter measurements, 2) 3000-cps modulated 1.5% peak at 75-cps, 3) blank groove for rumble testing.



Manufacturers: Electronic  
and Electro-Mechanical  
Equipment & Components

402 EAST GUTIERREZ STREET P.O. Box 1500 SANTA BARBARA, CALIFORNIA WOODLAND 5-4511

## SALES TERMS AND CONDITIONS

### Applicability

All quotations by D & R, Ltd. covering its products are made, and all purchase orders are accepted, subject to these terms and conditions, except as specifically provided by written agreement.

### Prices

Prices are subject to change without notice, and do not include local, state, or federal sales and/or excise taxes.

### Quotation

Quotations are considered to have expired thirty (30) days after date of issuance, unless otherwise specified in writing.

### Payment

In cases where credit approval has not been established, Seller may request payment in advance or may ship items C.O.D. Where sales are made on a credit basis, the net amount of the invoice becomes due within thirty (30) days of the invoice date.

### Acceptance

The Seller is not bound by any terms listed on Buyer's orders or forms which are at variance with these terms and conditions, and Buyer's acceptance of any items covered by Buyer's order shall be deemed an acceptance of these terms. All contracts or orders are subject to acceptance and approval by Seller at its office in Santa Barbara, California.

### Delays

Seller is not liable for delays or defaults in delivery due to causes beyond its control, and not occasioned by its negligence, and reserves the right under these circumstances to terminate the order or to reschedule delivery against the order. In the event that a rescheduling of delivery becomes necessary, Buyer can agree to revised delivery schedule or can terminate the order.

### Warranty

D & R, Ltd. products are warranted during a period of ninety (90) days from the date of shipment to be free from defects in material or workmanship. The liability of Seller under this warranty is limited to replacing or repairing any units defective in these respects which are returned by Buyer upon instructions from the Seller during such warranty period, and which have not been subjected to misuse, neglect, improper installation, repair, alteration or accident. Seller shall have the right of final determination as to the existence and cause of a defect. In no event shall Seller be liable for collateral or consequential damages. This warranty is in lieu of any other warranty, expressed, implied or statutory, and no agreement extending it will be binding upon Seller unless in writing and signed by its duly authorized officer or representative.





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Manufacturers: Electronic  
and Electro - Mechanical  
Equipment & Components

11 June 1958

Library of Congress  
Washington 25, D.C.

Attention: Mr. Robert B. Carneal  
Chief Engineer  
Recording Laboratory

Gentlemen:

Mr. L. C. Fuller, our former representative  
in your area, has referred us your letter of 4 June 1958.

The Model FL-3C Flutter and Wow Meter has  
been redesigned and now is designated the Model FL-3D.  
The chief improvements are: better amplitude limiting,  
broader bandwidth, R.M.S. flutter indication, and flutter  
and wow filters selectable from the front panel. The  
instrument is priced at \$225.00 f.o.b. Santa Barbara and  
is available for immediate delivery.

Enclosed please find data on our Type 37-1002  
Flutter Test Record. This item is available for \$3.95 each  
in quantities less than 25 pieces. The 62-1002A Flutter  
Tape is available for \$10.00 each and contains 1.5% peak  
flutter at a rate of 75 cps on a 3000 cps carrier. An  
unmodulated section is also available for transports without  
recording heads. The 15 ips tape, Type 62-1001A is not  
available any longer.

Thank you for your interest in our products  
and please do not hesitate to call upon me for additional  
information.

Very truly yours,  
D & R, LTD.

A handwritten signature in dark ink, reading 'John A. Moseley'. The signature is written in a cursive style with a large, looping 'J' and 'M'.  
John A. Moseley  
Sales Manager

JAM/mrv  
Encl.





PRICE \$225<sup>00</sup>

### GENERAL INFORMATION

The Model FL-3D Flutter and Wow Meter has been designed as a general purpose instrument meeting the requirements for measuring flutter and wow as determined by the Standards Committee of the I. R. E. Outstanding features of this instrument are improved limiting, extended bandwidth, selectable flutter and wow filters, and RMS calibration of an averaging type circuit. In addition, low frequency drift information is available through a D. C. response output terminal.

### SPECIFICATIONS

**CARRIER FREQUENCY** 3000 cps—Established by factory calibration.

**FLUTTER RESPONSE** The bandwidth of the discriminator is sufficient to allow sidebands up to 250 cps to be demodulated with no more than 3 db attenuation with reference to 75 cps. Components up to 350 cps can easily be identified with an oscilloscope.

**INPUT SIGNAL REQUIRED** 0 dbm signal provides  $\pm 20$  db limiting. Full limiting can be obtained with as little as 0.1 V RMS.

**INPUT IMPEDANCE** 100,000 ohms.

**SCALE RANGES** 2% and 0.5% full scale. RMS calibration on sine wave flutter.

**ACCURACY** 10% within bandwidth restrictions.

**BANDWIDTH SELECTION** 0.5 to 6 cps wow, 6 cps to 250 cps flutter, and 0.5 to 250 cps overall.

**OUTPUTS** a) Front panel terminals for observing flutter and wow components on oscilloscope.  
b) Rear apron terminal provides D. C. to 150 cps output for graphic recording.

**TUBE COMPLEMENT** One 6U8, two 12AT7, two 6AL5, one 6X4, one 0A2, and four 1N69 crystal rectifiers.

**LINE POWER** 117 VAC, 50-400 cps, 30 watts

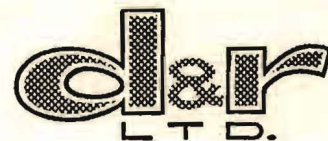
**DIMENSIONS** 7" x 12" x 6" Steel case

**WEIGHT** 10½ pounds



D & R FLUTTER AND RUMBLE TEST RECORD

TYPE 37-1002



FLUTTER TEST RECORD

TYPE 37-1002

TECHNICAL DATA AND INSTRUCTIONS FOR USE

D&R Flutter and Rumble Test Record Type 37-1002 is a precision mechanical standard for use as reference in making a number of types of measurements on record-playing equipment. The master is the result of a cooperative effort between D&R engineers and the skilled recording engineers of Capitol Records, using a Scully lathe under carefully controlled recording conditions. In the making of the pressings, especial effort has been taken to obtain the most accurate centering, and to maintain the highest signal-to-noise ratio by careful control of materials and processing.

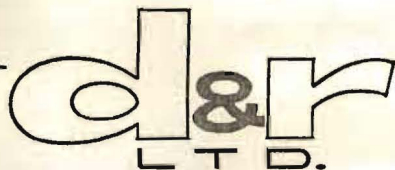
Bands 1 and 3 are designed for making basic physical measurements on record players, record changers, and phonograph turntables, while Band 2 carries a special frequency-modulated tone for use as a calibrating signal for flutter measuring instruments.

BAND 1. 3000 CYCLE PER SECOND UNMODULATED TONE.

The signal in this band has been recorded at a velocity of 7 centimeters per second, and the constancy of the tone is a result of the careful attention which has been given in the recording and pressing processes to obtaining the lowest possible flutter and the best possible centering. While 3000 c.p.s. has been chosen as the standard frequency for the making of measurements of flutter and wow, the fact that this frequency lies in a region of high auditory acuity permits the making of comparisons between systems of flutter and wow by listening tests in the absence of a flutter meter. To make a listening test of the flutter and wow in a reproducing system it is necessary only to play the record through the system in the normal manner, with the loudspeaker volume adjusted to a moderate sound level. Wow will be immediately apparent as a cyclic variation in the frequency of the tone as heard. Flutter, on the other hand, is not so obviously apparent; it is best described as a lack of cleanness or clarity in the sound. When flutter is excessive, as is frequently the case with record changers, it will be apparent to the ear as a "buzz" superimposed upon the 3000-cycle tone. Subjective listening tests on flutter and wow are interesting, but a flutter meter is a necessity for measurement work.

Measurement of Flutter and Wow

The D&R Model FL-3C Flutter Meter is especially suited for the measurement of flutter and wow of turntables, record changers, and record players in conjunction with the type 37-1002 Test Record. With a high-output crystal cartridge the record will deliver a signal level approximately 0.8 volts into the input terminals of the FL-3C. If the output level delivered by the cartridge is as low as 0.4 volts, which level will be indicated by a reading of approximately 0.1 in the set-level position of the FL-3C, satisfactory measurements can be made. However, under most conditions a conventional magnetic or dynamic pickup will be used in conjunction with a pre-amplifier.



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With a DR-12A Precision Turntable under careful test conditions, using the Type 37-1002 Test Record and the Model FL-3C Flutter Meter, a total flutter and wow indication between 0.09 and 0.14% can be obtained. This indication is equivalent to approximately 0.09% r.m.s. flutter and wow since the FL-3C Flutter Meter is calibrated in one-half the peak-to-peak value of flutter and wow.

Inspection on an oscilloscope or graphic recorder of the output signal from the FL-3C Flutter Meter while a measurement is being made will frequently indicate the source of the flutter and wow. Low-frequency undulations normally are caused by: inaccuracies in machining and in centering of components, unbalanced friction, variations in drive belts or idler wheels, and inaccuracies in conical drive surfaces. Higher frequency flutter components most commonly are the result of vibration in the drive motor. Spring-mounted motor arrangements are particularly susceptible to wow and flutter due to the softness of the suspension.

### Precise Measurement of Turntable Speed

Careful experimental analysis of the Type 37-1002 Test Record shows that 5412.8 cycles per revolution have been recorded. Hence, with the aid of a frequency counter, EPUT meter, or equivalent device for the precise measurement of frequency, the speed of a turntable can be determined with a high degree of accuracy. The output frequency derived from a pickup using the Type 37-1002 Test Record will be as given below when the turntable is turning exactly on speed:

33-1/3 r.p.m.--3007.1 c.p.s.; 45 r.p.m.--4059.6 c.p.s.; 78.26 r.p.m.--7060.1 c.p.s.

Obviously the presence of wow in the motion of the turntable will cause the measured frequency to vary to one side and the other of the average frequency as given above. With an EPUT meter this effect can be minimized by measuring the average frequency over a ten-second period. Conversely, the exact speed of the turntable can be determined by multiplying the measured frequency in c.p.s. by the factor 0.011085.

### BAND 2. 3000 CYCLE PER SECOND FREQUENCY-MODULATED TONE.

The signal recorded on Band 2 is a standard reference signal for the calibration of flutter measuring instruments. The carrier frequency of the signal is 3000 c.p.s., and the signal is frequency modulated with 1.5% peak amplitude at a modulation frequency of 75 c.p.s. The carrier frequency of this band is 3006 c.p.s. with the turntable turning at 33-1/3 r.p.m.

### BAND 3. SILENT GROOVE

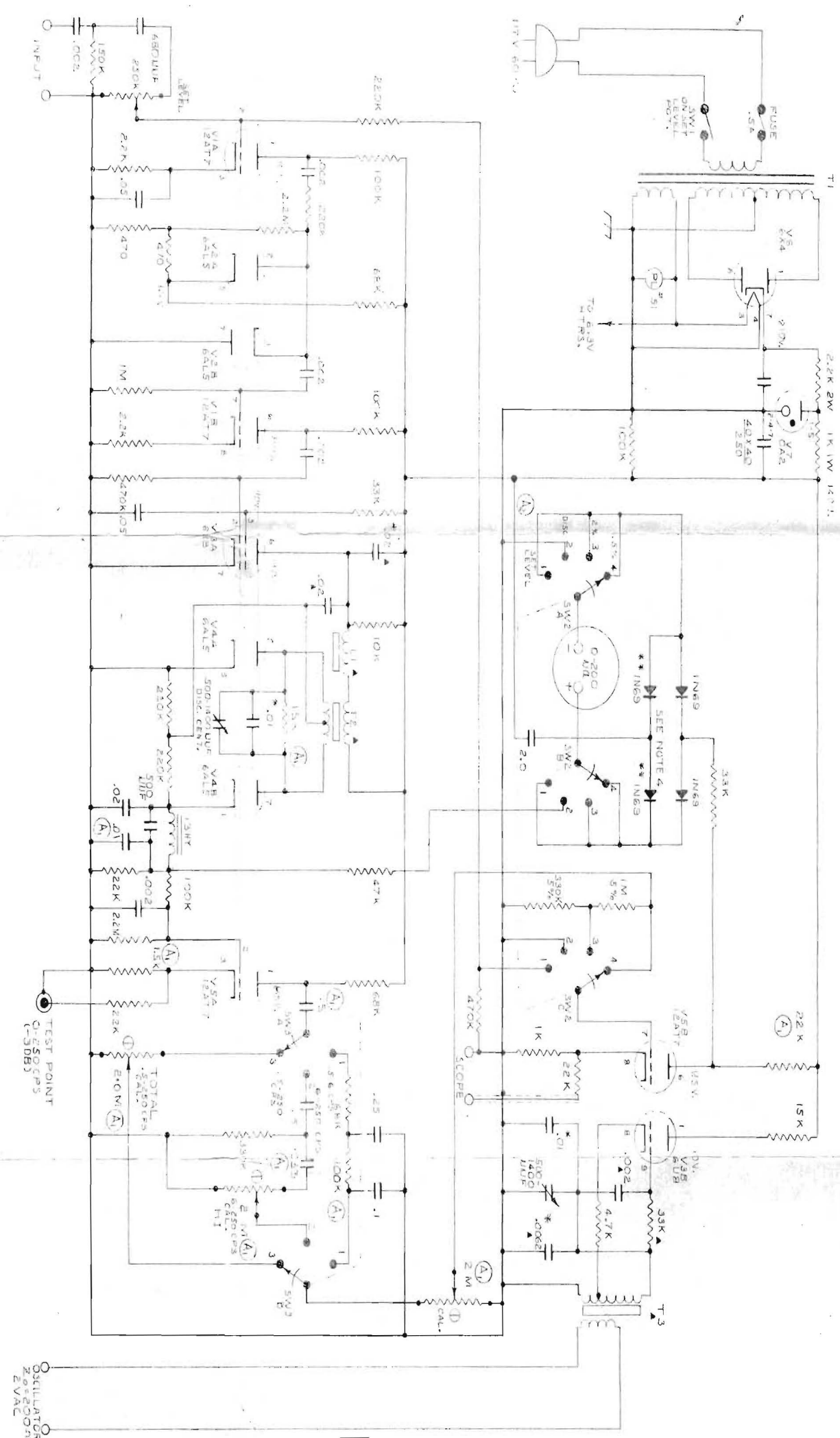
Band 3 is a silent groove in which an all out effort has been made to keep rumble and background noise to the lowest practicable level. Measurement has shown that this groove has substantially less rumble and noise than the great majority of top quality commercial records. Since wear and dust will soon increase the high-frequency noise content of this groove, it is suggested that the signal be passed through a sharp-cutoff 200-c.p.s. low-pass filter when this groove is to be used for careful rumble measurements.

Type 37-1002 Flutter and Rumble Test Record is a twelve-inch diameter pressing, 33-1/3 r.p.m. microgroove.

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D&R, Ltd., 402 East Gutierrez Street, Post Office Box 1500, Santa Barbara, California.





- NOTES:-
1. ALL RESISTORS HALF WATT EXCEPT WHERE NOTED.
  2. CAPACITOR VALUES IN MICROFARADS EXCEPT WHERE NOTED.
  3. AETERIK \* DENOTES TRIM VALUE.
  4. \* REPLACE WITH 3.3 K $\Omega$  WATT WHEN USING O-COULD METER.
  5. ▲ INDICATES THERMAL STABILITY WITHIN TRANSFORMER CAN.
  6. ALL VOLTAGE MEASUREMENTS MADE WITH 20000 OHMS/VOLT METER.

[illegible]